THE SUBLITTORAL ECOLOGY OF WEST ISLAND, SOUTH AUSTRALIA.

2. THE ASSOCIATION BETWEEN HYDROIDS AND ALGAL SUBSTRATE

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SUMMARY

The association between hydroids and benthic algae has been examined at West Island in Encounter Bay. Thirty-eight species of hydroids (of which 17 are new records for South Australia) are recorded epiphytic upon algae. Of these, 17 species show preference for particular algal substrates to a striking degree while 5 other species of very common occurrence are less selective of substrate, each being recorded on at least 10 species of algae.

Observations upon the nature of preferred and unfavoured algae suggest that some hydroid larvae are positively rugotactic, favouring rough, flat or depressed algal surfaces and avoid filamentous or mucus-coated species. The biochemical properties of some algae and the presence of a suitable surface film appear equally important so increasing the ecological possibilities of substratum preference by hydroids. Red algae (with 38 species) are a more favoured substrate than brown algae (with only 15 species).

The most important factor determining the distribution of epiyphtic hydroids in the sublittoral is the presence of suitable substrate algae. At West Island, optimal conditions exist in the mid-sublittoral between 12 and 20 m on the rough windward shore, where there is a rich red algal flora; here, there is an abundant epiphytic hydroid fauna in terms of species and density.

INTRODUCTION

Reports upon the association between benthic animals and algae in the sublittoral zone are rare. Rogick and Croasdale (1949) in the region of Woods Hole, U.S.A. and Ryland (1962) on the English Coast have noted the association of bryozoa and algae; Sloane et al. (1961) has reported upon the fauna on algae in Lough Ine, Eire. Following the account of Kato et al. (1951), Nishihira (1965, 1966, 1967a, 1967b, 1968a, 1968b) studied the ecology of hydroids in the region of Asamushi, Japan.

Detailed reports of this kind for Australian waters are lacking although fragmentary information about the algal substrate of hydroids may be found in the papers of Bale (1884), Bartlett (1907), Mulder and Trebilcock (1911), Blackburn (1937, 1938, 1942), Hodgson (1950), Ralph (1956) and Pennycuick (1959).

This paper is the second of a series of studies upon algae and their associated fauna about West Island, Encounter Bay. An account of the sublittoral environment and of the algal distribution at West Island is given by Shepherd and Womersley (1970).

Hydroids attached to rocky substrates, or found among holdfast fauna are not included in this study and will be the subject of a later paper by the second author. Notes are made upon the abundance, fertile seasons and ecology of the species found. Microslides of hydroids examined in this study are lodged in the National Museum of Victoria, the South Australian Museum and held in the personal collection of the second author.

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TABLE 1

Hydroid epiphytes on algae

o indicates new record for South Australia

* indicates months when fertile colonies found

		Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
F. CAMPANULARIIDAE													
Campanularia undiplica Mulder & Trebilock 1914	o												
Campanularia australis Stechow 1924													
Orthopyxis caliculata (Hincks 1853)		*											
Orthopyxis angulata Bale 1914	o											*	
Obelia geniculata (Linne. 1758)											*		*
Silicularia bilabiata (Coughtrey 1875)	o	*								*	*		
F. SYNTHECIIDAE													
Diphasia subcarinata (Busk 1852)													
Synthecium sp.													
F. LINEOLARIIDAE													
Lineolaria spinulosa Hincks 1861	o												
F. HALECIIDAE													
Scoresbia daidala Watson 1969	o	*											
F. SERTULARIIDAE													
Stereotheca elongata (Lamouroux 1816)		*			*		*				*	*	
Crateritheca acanthostoma (Bale 1882)		*											
Amphisbetia minima (Thompson 1879)		*		*	*				*	*	*	*	*
Amphisbetia maplestonei (Bale 1884)													
Amphisbetia minuta (Bale 1882)	o												
Amphisbetia pulchella (Thompson 1879)													*
Sertularia acuta Stechow 1921	o												
Sertularia geminata Bale 1884		*								*			
Sertularia mccallumi Bartlett 1907	o	*											
Sertularia macrocarpa Bale 1884	o												
Sertularia obliquanoda Mulder & Trebilcock 1914	o												
Symplectoscyphus neglectus (Thompson 1879)		*							*	*	*	*	
Symplectoscyphus indivisus (Bale 1882)		*								*			
Symplectoscyphus macrothecus (Bale 1882)	o												
Sertularella robusta Coughtrey 1875							*		*	*			
Dynamena quadridentata (Ellis & Solander 1786)													
F. PLUMULARIIDAE													
Antennella sp.													
Plumularia alata Bale 1888	o	*											*
Plumularia flexuosa Bale 1894													
Plumularia spinulosa var. *spinulosa* Bale 1882	o												
Plumularia filicaulis Kirchenpauer 1876	o	*									*		
Halopteris aglaopheniaformis Mulder & Trebilcock 1909	o								*				
Pycnotheca producta Bale 1882										*			
Aglaophenia plumosa Bale 1882													
Thecocarpus divaricatus var. *mccoyi* Bale 1882	o								*	*	*	*	
Halicornaria longirostris (Kirchenpauer 1872)													
Halicornaria ascidioides Bale 1884	o												
Halicornopsis elegans (Lamarck 1816)													

METHOD

Algae collected at approximately monthly intervals during the algal survey of West Island in 1967 and 1968 (Shepherd & Womersley, 1970) by the first author were examined for the presence of hydroids, and observations were made upon their fertile season. The algae were identified by the first author, and in cases of difficulty, by Dr. H. B. S. Womersley, and hydroid determinations were made by the second author. In addition, algae collected early in the survey in 1965 and 1966 and mounted on herbarium sheets in the Botany Department of the University of Adelaide, were examined by us. Although this material was dried and pressed, it was not difficult to recognize most hydroids. A few species required reconstitution in water before identification was certain, and only *Antennella* sp. and *Synthecium* sp. could not be identified to species. In this way, the common species of algae were examined on numerous occasions and uncommon species were checked several times.

Abundance of hydroid growth was estimated subjectively by taking into account frequency of occurrence and luxuriance of spread of a colony upon a substrate. This method was found satisfactory as growth was either profuse and occurred on a majority of plants of an individual species or was only occasionally or rarely recorded. Hence the results, based upon a large number of observations at all times of the year give a good overall picture of the incidence of epiphytic hydroids. Nevertheless, it is possible that further collecting will produce additional records as the abundance of some hydroids was found to vary seasonally and from year to year.

RESULTS AND DISCUSSION

The epiphytic hydroids and the months in which they are fertile are recorded in Table 1. Athecate hydroids were not found growing on algae probably because the unprotected hydranth is unable to withstand turbulent conditions.

Some hydroids, listed in Table 2, were found on very few occasions, so that their constant association with particular algae is not established; it is likely that some of these hydroids occur on other substrates as well.

The hydroids listed in Tables 3 and 4 are all associated with particular algae and the results show that these hydroids are selective of substrate in varying degrees. They are discussed in three groups, according to the degree of selectivity. The authors of hydroid species are given in Table 1 and the authors of the species of algae from West Island are given by Shepherd and Womersley (1970).

(a) *Species showing least selectivity*

The species in this group are:
Amphisbetia minima, *Campanularia australis*, *Plumularia filicaulis*, *Symplectoscyphus neglectus*, *Stereotheca elongata.*

TABLE 2
Hydroids seldom found on algae

Hydroid	Algal Substrate
Amphisbetia maplestonei	*Plocamium* sp.
Amphisbetia minuta	*Carpopeltis phyllophora*
Antennella sp.	*Pterocladia lucida*
Campanularia ambiplica	*Seirococcus axillaris*
	Crassilingua marginifera
Diphasia subcarinata	*Laurencia filiformis*
	Metamastophora flabellata
Dynamena quadridentata	*Laurencia filiformis*
Halicornaria ascidioides	*Plocamium preissianum*
Halopteris aglaopheniaformis	*Rhodophyllis multipartita*
Lineolaria spinulosa	*Carpopeltis phyllophora*
	Rhodymenia australis
Plumularia alata	*Zonaria spiralis*
Plumularia flexuosa	*Peyssonelia gunniana*
Pycnotheca producta	*Rhodymenia australis*
Sertularia geminata	*Laurencia elata*
	Laurencia filiformis
	Acrocarpia paniculata
Sertularia obliquanoda	*Gelidium australe*
Symplectoscyphus macrothecus	*Cystophora subfarcinata*
Synthecium sp.	*Laurencia filiformis*

TABLE 3

Showing hydroids associated with brown algae. v.c. = very common; c. = common; occ. = occasional

	Amphisbetia minima	*Campanularia australis*	*Halicornaria longirostris*	*Obelia geniculata*	*Orthopyxis angulata*	*Orthopyxis caliculata*	*Plumularia filicaulis*	*Plumularia spinulosa* var. *spinulosa*	*Scoresbia daidala*	*Sertularella robusta*	*Silicularia bilabiata*	*Stereotheca elongata*	*Symplectoscyphus indivisus*	*Symplectoscyphus neglectus*	Number of hydroid species associated with this alga
Lobospira bicuspidata							occ			occ					2
Zonaria angustata	occ									occ					2
Zonaria crenata									vc						1
Zonaria sinclairii	occ		occ										occ		3
Zonaria spiralis	occ														1
Perithalia caudata		occ												occ	2
Ecklonia radiata				vc											1
Acrocarpia paniculata		occ				occ		occ				c	occ		5
Cystophora monilifera										occ					1
Cystophora moniliformis		occ													1
Cystophora subfarcinata		vc													1
Scytothalia dorycarpa											c				1
Seirococcus axillaris											c		occ		2
Sargassum bracteolosum	vc	occ													2
Sargassum verruculosum	occ	occ			occ			occ							4
Number of species epiphytised by this hydroid	5	6	1	1	1	1	1	2	1	3	2	1	3	1	

These are the most common hydroids of the region and several factors appear to contribute to their abundance. Although they occur on numerous species of algae, they are preferentially associated with a few species some of which are very common in the sublittoral, with the result that there is an abundance of available substrate on which their larvae may settle. The fact that three of them (*A. minima*, *S. elongata* and *S. neglectus*) are fertile for most of the year (Table 1) no doubt also contributes to their prevalence (cf. Nishihira, 1966).

(b) *Species showing most selectivity*

Two species were observed in association with only one alga, and one species was observed in association with the two related species of algae. These are:—

Obelia geniculata with *Ecklonia radiata*

Scoresbia daidala with *Zonaria crenata*

*Silicularia bilabiata** with *Scytothalia dorycarpa* and *Seirococcus axillaris*

In the first two cases, the association appears to be obligatory as these two hydroids have not been recorded in southern Australia on any other substrate. (See Womersley, 1967, p. 226; Watson, 1969, p. 115). However, *Obelia geniculata*

* There is also a solitary record of this hydroid on *Acrocarpia paniculata*.

TABLE 4

Showing hydroids associated with red algae

	Aglaophenia plumosa	*Amphisbetia minima*	*Amphisbetia pulchella*	*Campanularia australis*	*Crateritheca acanthostoma*	*Halicornaria longirostris*	*Orthopyxis caliculata*	*Plumularia filicaulis*	*Plumularia spinulosa* var. *spinulosa*	*Sertularella robusta*	*Sertularia acuta*	*Sertularia maccallumi*	*Sertularia macrocarpa*	*Stereotheca elongata*	*Symplectoscyphus indivisus*	*Symplectoscyphus neglectus*	*Thecocarpus divaricatus* var. *mccoyi*	Number of hydroid species associated with this alga
Gelidium australe					occ	occ				occ		occ		c	occ	occ	occ	8
Gelidium glandulaefolium		occ			occ	occ				occ		occ		c		occ		7
Pterocladia lucida	occ	c		c				occ						occ	occ	occ		7
Corallina sp.		occ																1
Metamastophora flabellata		occ							occ	occ								3
Sonderophycus australis		occ	occ												occ			3
Peyssonelia gunniana										occ								1
Carpopeltis phyllophora		c							occ			occ						3
Polyopes constrictus																occ		1
Thamnoclonium dichotomum														occ				1
Callophyllis coccinea		occ																1
Melanthalia concinna														occ				1
Melanthalia obtusata												occ		c				2
Phacelocarpus apodus											occ							1
Phacelocarpus complanatus															occ			1
Phacelocarpus labillardieri					occ	occ	occ				c	occ		vc	occ	c	occ	9
Nizymenia australis		c						c	* occ		c			vc		c	occ	7
Callophycus laxus					c									occ				2
Areschougia dumosa														occ		occ		2
Rhodophyllis multipartita		occ					occ			c				occ		occ		5
Plocamium angustum		occ						occ								occ		3
Plocamium coccineum		occ																1
Plocamium costatum		occ				occ		occ					occ					4
Plocamium mertensii	occ		occ					occ					occ			occ		5
Plocamium patagiatum								c					occ			occ		3
Plocamium preissianum	occ	c					occ	occ	c		occ	occ		occ		c	occ	10
Acrotylus australis		occ												occ		c		3
Rhodymenia australis	occ	c	occ	occ			occ	c	occ			occ				occ		9
Acrothamnion preissii				occ														1
Ballia callitricha				c														1
Euptilota articulata																occ		1
Apoglossum tasmanicum		occ		c				c										3
Crassilingua marginifera										occ							occ	2
Hymenena multipartita		c						occ										2
Laurencia clavata	occ	occ		occ				occ								occ	occ	6
Number of species epiphytised by this hydroid	5	18	3	6	4	4	4	11	5	6	4	7	3	13	5	16	6	

* In this case, the hydroid is usually epizoic on the sponge *Callyspongia* sp. which encrusts the algal surface.

and *Silicularia bilabiata* are recorded growing on *Macrocystis pyrifera* (L.) Agardh in New Zealand waters (Ralph, 1956), and *Obelia geniculata* is reported upon *Laminaria digitata* (Huds.) Lamour. on the British coast (Robins, 1969) and upon *Symphyocladia latiuscula* (Harv.) Yamada by Nishihira (1966) in Japanese waters. Evidently, preference for a particular alga is a local characteristic of both *Silicularia bilabiata* and *Obelia geniculata* and varies over their geographic ranges according to substratum possibilities.

(c) *Species showing some selectivity*

The remaining hydroids in Tables 3 and 4 are all found on relatively few species of algae, indicating that some are more favourable than others; however, only 5 species (*Crateritheca acanthostoma*, *Lineolaria spinulosa*, *Plumularia spinulosa* var. *spinulosa*, *Sertularella robusta* and *Sertularia acuta*) show a strong preference for a particular alga.

Algae as Substrate

It is clear from Tables 3 and 4 that at West Island the red algae as a group are the most favourable substrate for hydroids. Except for three species, brown algae are generally unfavourable and green algae never seem to bear hydroids.

According to Nishihira (1966, 1967a, 1968a) the physical and chemical nature of the substrate is of fundamental importance to hydroid larvae. Our observations are in agreement. Algae with flat laminar thalli, concavities or rugose surfaces are favoured substrate and nearly all red algae on which four or more hydroid species grow have these physical characteristics. Of the brown algae commonly epiphytised, *Sargassum bracteolosum* has flat and somewhat rugose basal fronds and *Acrocarpia paniculata* has a rough and warty stem. However, the attractiveness of other algae without these physical qualities, e.g. *Melanthalia* spp. and *Gelidium* spp. which are mucus-coated or possess finely divided ramuli may depend upon a positive chemotaxis among hydroid larvae as reported by Nishihira (1968b).

Conversely some physical and chemical characteristics of algae may be adverse to hydroids. Generally, filamentous or finely divided algae (e.g. *Ballia mariana*, *Corynospora* spp. *Pterocladia capillacea* and *Halopteris* spp.) do not carry hydroids. Nishihira (1967a) attributed this to the fact that the filaments of such algae are smaller in diameter than the larvae and stolons of hydroids.

The general absence of epiphytes on brown algae is probably due to the presence of tannic substances secreted by their tissues (Conover with Sieburth 1964, Sieburth and Conover 1965). These tannins possess antibiotic properties inhibiting settlement of larvae on the alga, and are found in many brown algae (Ogino 1962, McLachlan and Craigie 1964).

Some red algae (e.g. *Rhodophyllis membranacea*, *Haloplegma preissii* and *Epiphloea bullosa* (?)) also appear to secrete mucus and this may make them unattractive to hydroid larvae. Corallinaceous species (e.g. *Corallina* spp., and *Amphiroa anceps*) are also not colonised by hydroids.

The oldest part of the thallus of an alga is generally colonised first. *Ecklonia radiata*, which grows at the transition zone between stipe and frond, is usually colonised first on the distal part of the frond whereas red and brown algae which grow apically tend to be colonised first on the stem. Algae in their first season of growth are usually quite clean and this may be a useful field method for aging some species. The evident preference by hydroid larvae for a substrate which has aged may be due to the acquisition by the blade of the alga of a suitable surface film (Nishihira 1968b) or may be due to a seasonal variation or a decline in antibacterial activity by the alga (Sieburth and Conover 1965).

Distribution of Hydroids

In general, the occurrence of epiphytic hydroids appears to be related to the availability of suitable substrate algae rather than to any direct environmental effect. Hence, the distribution of hydroids about West Island is determined by the distribution patterns of its preferred substrates.

For this reason, epiphytic hydroids are relatively scarce on the protected lee shore of the island where brown algae are dominant, but are abundant in the mid and lower sublittoral zones on the rough windward side of the island where there is a rich and varied red algal flora, as described in detail by Shepherd and Womersley (1970). However, the distribution of three hydroids (*Obelia geniculata*, *Orthopyxis angulata* and *Orthopyxis caliculata*) is exceptional as they occur only in fairly sheltered conditions although their host algae are more widely distributed. These species all liberate free-swimming medusae and it is possible that species which reproduce in this way are not adapted to rough conditions.

The abundance of epiphytic hydroids is greater in a shaded micro-habitat than on horizontal rock surfaces, and an alga growing on the former site is generally more heavily epiphytised than the same species growing in a situation which is better lighted. Also, many of the records in Table 2 are from shaded habitats. The increased abundance of hydroids both in species and in density in shade may be due to a preference for lower light intensities or to factors associated with reduced light such as the increased growth of encrusting epibiota on algae in these conditions, resulting in a more attractive substrate.

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